

June 2006

DEFENSE MANAGEMENT

Additional Measures to Reduce Corrosion of Prepositioned Military Assets Could Achieve Cost Savings





Highlights of [GAO-06-709](#), a report to congressional committees

Why GAO Did This Study

The military services store prepositioned stocks of equipment and material on ships and land in locations around the world to enable the rapid fielding of combat-ready forces. GAO's prior work has shown that the readiness and safety of military equipment can be severely degraded by corrosion and that the Department of Defense (DOD) spends billions of dollars annually to address corrosion. GAO was asked to review the impact of corrosion on prepositioned assets. GAO's specific objectives were to assess (1) the measures taken by the Army and the Marine Corps to reduce the impact of corrosion on prepositioned assets and (2) the availability of corrosion-related data to the Army and the Marine Corps to support corrosion prevention and mitigation efforts for prepositioned assets.

What GAO Recommends

To reduce the impact of corrosion on prepositioned assets and support additional corrosion prevention and mitigation efforts, GAO is recommending that the Army examine the feasibility of using temporary shelters to store land-based prepositioned assets currently stored outdoors and that the Army and Marine Corps enhance their efforts to collect corrosion-related data on prepositioned assets. DOD concurred with GAO's recommendations.

www.gao.gov/cgi-bin/getrpt?GAO-06-709.

To view the full product, including the scope and methodology, click on the link above. For more information, contact William Solis at (202) 512-8365 or solisw@gao.gov.

DEFENSE MANAGEMENT

Additional Measures to Reduce Corrosion of Prepositioned Military Assets Could Achieve Cost Savings

What GAO Found

The Army and Marine Corps have taken some measures to reduce the impact of corrosion on prepositioned assets, primarily through the use of humidity-controlled storage facilities on ships and in some land-based locations, but a substantial portion of Army land-based prepositioned assets are stored outdoors and are left relatively unprotected from elements that contribute to corrosion. When equipment was drawn for military operations for Operation Iraqi Freedom during 2003, it was reported in good operating condition and not degraded by corrosion. Most of this equipment had been stored in humidity-controlled facilities. However, whereas all Marine Corps prepositioned assets are stored in humidity-controlled facilities, the Army currently stores a significant amount of its land-based prepositioned assets outdoors. Under Army policy, the preferred method for storing prepositioned assets is in humidity-controlled facilities because outdoor storage makes equipment more susceptible to corrosion and increases maintenance requirements and costs. One Army study showed that sheltering equipment in a humidity-controlled facility had a return on investment, at minimum, of \$8 for every \$1 invested. In South Korea, the Army has recently completed an intensive effort to repair prepositioned assets and correct some long-standing problems, but almost one-third of the assets continue to be stored outside. Similarly, as the Army reconstitutes its prepositioned equipment in Southwest Asia, thousands of Army equipment items in Kuwait are stored outdoors in harsh environmental conditions. Army officials cited competing funding priorities and other factors as reasons for not providing indoor storage for all land-based prepositioned assets. However, temporary shelters may be a feasible option to address immediate storage needs. The Army has used temporary shelters and humidity-controlled storage for some prepositioned assets.

Although the Army requires corrosion-related data collection for equipment items and Marine Corps officials believe them to be beneficial, data that could help reduce corrosion of prepositioned assets are not available. They are not available because the services consider this information to be a low priority and do not systematically collect it. Without these data, the services are not in a position to identify causes of corrosion, support efforts to more effectively reduce corrosion, and achieve long-term cost savings. Army and Marine Corps documents include information on the maintenance condition, actions, and costs for prepositioned equipment, but provide little data on corrosion. While cost data are limited, the services have estimated that about 25 percent of overall equipment maintenance costs are corrosion related and perhaps as much as one-third of these costs could be reduced through more effective corrosion prevention and mitigation. An Army review of maintenance records for about 2,000 pieces of prepositioned stock in South Korea found that \$8.7 million (31 percent) of the estimated \$28 million spent to restore this equipment was used to address corrosion. The Army has had previous success using corrosion data on non-prepositioned equipment programs to support corrosion prevention and mitigation.

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United States Government Accountability Office
Washington, DC 20548

June 14, 2006

The Honorable Thad Cochran
Chairman
The Honorable Robert C. Byrd
Ranking Minority Member
Committee on Appropriations
United States Senate

The Honorable Jerry Lewis
Chairman
The Honorable David R. Obey
Ranking Minority Member
Committee on Appropriations
House of Representatives

The Army and the Marine Corps store prepositioned stocks of equipment and material on ships and land in locations around the world to enable the rapid fielding of combat-ready forces. These prepositioned stocks are a strategic asset for projecting military power and have been used extensively to support military operations in Southwest Asia. The Army stores sets of brigade equipment and supporting supplies at land sites in several countries as well as aboard prepositioning ships in the Pacific and Indian Oceans. Each of the Army's prepositioned brigade sets is designed to support 3,000 to 5,000 soldiers. The Marine Corps stores equipment and supplies for its forces aboard squadrons of maritime prepositioning ships around the world as well as in Norway. Each of the Marine Corps' three prepositioning squadrons is designed to support 13,000 Marines for up to 30 days. We have previously raised concerns about the oversight and direction of military prepositioning programs.¹ For example, we have reported that the services lacked sufficient information on the inventory level and maintenance condition of some prepositioned stocks. In addition, future plans for prepositioned assets are likely to be affected by

¹GAO, *Defense Logistics: Better Management and Oversight of Prepositioning Programs Needed to Reduce Risk and Improve Future Plans*, [GAO-05-427](#) (Washington, D.C.: Sept. 6, 2005).

the availability of funding, spare part and equipment stocks shortages, and the effects of transformation.²

Because prepositioned assets are critical to the readiness of combat forces, the military services must keep these items in good operating condition. Among the challenges the services face in keeping their equipment and supplies in good operating condition is corrosion caused by exposure to the environment.³ Corrosion, if left unchecked, can degrade the readiness and safety of equipment and has been estimated to cost the Department of Defense (DOD) billions of dollars annually. The military services have established programs aimed at minimizing the impact of corrosion on their assets, and DOD has developed a long-term corrosion prevention and mitigation strategy.

This report responds to a request in the Conference Report accompanying the fiscal year 2006 Defense Appropriations Bill that we review the impact of corrosion on prepositioned assets.⁴ Our specific objectives were to assess (1) the measures taken by the Army and the Marine Corps to reduce the impact of corrosion on prepositioned assets and (2) the availability of corrosion-related data to the Army and the Marine Corps to support corrosion prevention and mitigation efforts for prepositioned assets.

Our review focused on prepositioned stocks managed by the Army and Marine Corps because these two services have the largest amounts of prepositioned equipment and provided most of the equipment used in current operations in Southwest Asia. To conduct our work, we reviewed the services' policies, procedures, and practices for managing and maintaining prepositioned assets; analyzed various reports on these assets, including inspection and maintenance reports; visited selected maintenance facilities and prepositioning sites; and discussed corrosion issues with officials responsible for managing and maintaining prepositioned assets and for managing corrosion prevention and

²Among recent changes, the Army is reconstituting prepositioning stocks in Southwest Asia and recently completed a significant effort to repair prepositioned items in South Korea. In addition, the Army plans to cut its afloat prepositioning capability in half (from two brigade sets to one) and is planning to reduce the contractor workforce at Goose Creek, South Carolina, where maintenance is performed on the equipment.

³Corrosion is defined under 10 U.S.C. Section 2228 as the deterioration of a material or its properties caused by a reaction of that material with its chemical environment.

⁴H.R. Conf. Rpt. 108-622, at 98.

mitigation programs. We determined that the data used were sufficiently reliable for our purposes. We conducted our work from May 2005 through February 2006 in accordance with generally accepted government auditing standards. The scope and methodology section contains more detailed information on the work we performed.

Results in Brief

The Army and the Marine Corps have taken some measures for reducing the impact of corrosion on prepositioned assets, primarily through the use of humidity-controlled storage facilities on ships and in some land-based locations, but a substantial portion of Army land-based prepositioned assets are stored outdoors and, therefore, are left relatively unprotected from moisture, sand, and other elements that contribute to corrosion. When prepositioned equipment was drawn by Army and Marine units for military operations for Operation Iraqi Freedom during 2003, it was reported to be in good operating condition and was not degraded by corrosion. Most of this equipment had been stored in humidity-controlled facilities. However, the Army is currently storing a significant amount of its land-based prepositioned assets outdoors. In contrast, all Marine Corps prepositioned assets are stored in humidity-controlled facilities both on ships and in caves in Norway. Under Army policy, the preferred method for storing prepositioned assets is in humidity-controlled facilities because outdoor storage makes equipment more susceptible to corrosion that degrades its condition and increases maintenance requirements and costs. One Army study showed that sheltering equipment in a humidity-controlled facility had a return on investment, at minimum, of \$8 for every \$1 invested. In South Korea, the Army has recently completed an intensive effort to repair prepositioned assets and correct some long-standing problems, but almost one-third of prepositioned assets, including brigade-set and sustainment stocks, continue to be stored outside rather than in shelters. Similarly, as the Army reconstitutes its prepositioned equipment in Southwest Asia, thousands of Army prepositioned equipment items in Kuwait are stored outdoors in harsh environmental conditions, requiring more frequent maintenance than would be the case if shelters were used. The Army's prepositioned afloat maintenance facility in South Carolina also lacks humidity-controlled storage for equipment awaiting upload to ships, and equipment is stored outside anywhere from 1 to 3 months, on average. Army officials cited a number of factors, primarily competing funding priorities, as reasons for not providing indoor storage for all land-based prepositioned assets. However, temporary shelters may be a feasible option to address immediate storage needs. The Army has used temporary shelters and humidity-controlled storage for some prepositioned assets.

Although Army regulations require corrosion-related data to be collected for equipment items and Marine Corps officials believe them to be beneficial, corrosion-related data that could enhance efforts to prevent and mitigate corrosion of prepositioned assets are not available. They are not available because the Army and Marine Corps consider this information to be a low priority and therefore do not systematically collect it. Without these data, the services are not in a position to identify the underlying causes of corrosion, support efforts to more effectively prevent and mitigate corrosion, and achieve long-term cost savings. Army and Marine Corps documents we reviewed include information on the maintenance condition, repair actions, and costs for prepositioned equipment, but provide little data regarding the extent and nature of corrosion found during the maintenance process. Army and Marine Corps officials said corrosion is routinely treated as part of the overall maintenance process and, given its low priority, corrosion-related data are not tracked separately. Although the Army and Marine Corps are not collecting data about the current costs to prevent and mitigate corrosion of prepositioned assets, the services have estimated that about 25 percent of overall maintenance costs are corrosion related and perhaps as much as one-third of these costs could be reduced through more effective corrosion prevention and mitigation. At our request, the Army conducted a limited review of maintenance records for about 2,000 pieces of prepositioned stock in South Korea and found that about \$8.7 million (31 percent) of the estimated \$28 million spent to restore this equipment to serviceable condition was used to address corrosion-related problems. Information that would be obtained through the collection of corrosion data could support the Army's and Marine Corps' efforts to more effectively prevent and mitigate corrosion and achieve long-term cost savings. The Army has had previous success using corrosion data on non-prepositioning equipment programs to support corrosion prevention and mitigation actions. Two examples where such actions resulted in cost savings are the Army National Guard's humidity-controlled shelter program and the Army's Hellfire missile program.

To reduce the impact of corrosion on prepositioned assets and support additional corrosion prevention and mitigation efforts, we are recommending that the Army examine the feasibility of using temporary shelters to store land-based prepositioned assets currently stored outdoors and that the Army and Marine Corps enhance their efforts to collect corrosion-related data on prepositioned assets. In commenting on a draft of this report, DOD concurred with our recommendations. DOD's response is reprinted in appendix II.

Background

Prepositioned equipment and supplies are strategic assets, along with sealift and airlift, for projecting military power. These assets include combat equipment, spare parts, and sustainment supplies that are stored on ships and on land in locations around the world to enable the rapid fielding of combat-ready forces. (App. I provides an overview of the military services' prepositioned assets and their locations.) DOD has made significant investments in its military prepositioning programs, totaling several billion dollars in annual acquisition costs. In addition, the services have collectively used an average of over \$1 billion each year to operate and maintain these assets. For example, in fiscal year 2005, the Army spent \$386.1 million for storage and maintenance of prepositioned assets, including \$76.5 million for assets in South Korea and \$38.3 million for assets in Southwest Asia. Prepositioned assets have been used extensively to support operations in Iraq and Afghanistan. The Marine Corps used equipment from two of its three prepositioned squadrons to support these operations. The Army used nearly all of its prepositioned ship stocks and land-based stocks in Kuwait and Qatar, in addition to drawing some equipment from Europe.

Military equipment and infrastructure are often located in corrosive environments that increase the deterioration of assets and shorten their useful life. The extensive and long-term deployments of U.S. troops in Southwest Asia are likely to magnify the effects of corrosion on military equipment, including prepositioned assets, because of the region's harsh operating environment. Higher rates of corrosion result in increased repairs and replacements, drive up costs, and take critical systems out of action, reducing mission readiness. Corrosion can also reduce the safety of equipment items. Although reliable cost data are not available, estimates of corrosion costs DOD-wide have ranged from \$10 billion to \$20 billion annually. We have found in our prior work that DOD and the military services did not have an effective management approach to mitigate and prevent corrosion.⁵ We recommended that DOD develop a departmentwide strategic plan with clearly defined goals, measurable outcome-oriented objectives, and performance measures. DOD concurred and in December 2003 issued its corrosion strategy.⁶

⁵GAO, *Defense Management: Opportunities to Reduce Corrosion Costs and Increase Readiness*, GAO-03-753 (Washington, D.C.: July 7, 2003).

⁶Office of the Secretary of Defense, *Long-Term Strategy to Reduce Corrosion and the Effects of Corrosion on the Military Equipment and Infrastructure of the Department of Defense* (December 2003).

According to DOD's corrosion strategy, knowing the costs of corrosion is essential to adequately implementing the strategy, and having corrosion data helps the department learn what works so it can be more effective in reducing corrosion. In addition, the Defense Science Board in 2004 stated that "accurate and objective corrosion data collection and new incentives to reward life-cycle cost reduction efforts must be implemented" as part of an effective corrosion control program and that such data are critical "not only to understand the depth of the problem, but to enable a quantitative corrosion mitigation strategy, which is founded on fact."⁷

Army and Marine Corps Have Taken Some Measures to Reduce Impact of Corrosion on Prepositioned Assets, but the Army Could Increase Its Use of Storage Facilities

The Army and Marine Corps have taken some measures to reduce the impact of corrosion on prepositioned assets, but the Army could increase its use of storage facilities for land-based assets. Prepositioned equipment drawn by Army and Marine Corps units for military operations in Iraq during 2003 had mostly been stored in humidity-controlled facilities and was reported to be in good operating condition and was not degraded by corrosion. The primary measure taken to reduce corrosion and achieve this good operating condition was the use of humidity-controlled storage facilities. However, we identified several locations where the Army is currently storing a substantial portion of its prepositioned equipment outdoors. Temporary shelters may be a feasible option to address immediate storage needs.

Prepositioned Equipment Deployed for Military Operations Was Reported to Be in Good Operating Condition

When prepositioned equipment was drawn by Army and Marine Corps units in military operations in Iraq during 2003, it was reported to be in good working condition and was not degraded by corrosion. Army officials from the 3rd Infantry Division have stated that with the exception of rubber seals on some vehicles, prepositioned equipment entering Southwest Asia was in good shape and had minimal, if any, corrosion. These officials said they did not experience any corrosion that affected their ability to perform operations. Similarly, officials with the 1st and 2nd Marine Expeditionary Forces who used or observed the use of prepositioned equipment in Southwest Asia found it was in a high state of readiness and could not recall any instance where corrosion affected their ability to perform operations. Furthermore, officials with the 3rd Marine

⁷Defense Science Board, *Report on Corrosion Control* (October 2004).

Expeditionary Force said the equipment on the prepositioning ship *USNS Lummus* that was used in a 2004 training exercise in South Korea was generally in the same good operating condition it was when first uploaded about 2 years previously. These officials stated that subsequent maintenance in August 2005 confirmed that the equipment continued to be in good operating condition based on a detailed examination of about 200 pieces of this equipment. They told us that with the exception of minor hydraulic leaks and o-ring deterioration, the equipment was generally free of corrosion problems.

Humidity-Controlled Facilities Have Helped Reduce Corrosion

The primary measure to reduce corrosion of Army and Marine Corps prepositioned assets has been the use of humidity-controlled storage facilities. Most of the prepositioned equipment drawn for military operations in Iraq during 2003 had been stored, either afloat or on land, in such facilities. Under Army policy, the preferred method for storing prepositioned assets is in humidity-controlled facilities because such storage is considered highly effective in preserving equipment. Maintaining low humidity levels reduces corrosion because moisture is a primary cause of corrosion. Similarly, Marine Corps policies indicate that equipment should be sheltered in climate-controlled facilities to the greatest extent possible. Army and Marine Corps officials told us that the use of humidity-controlled facilities is effective at minimizing equipment corrosion and maintaining high readiness levels.⁸ Army equipment on prepositioning ships is stored below deck in humidity-controlled cargo space. In addition, the Army stores some of its land-based prepositioned equipment in humidity-controlled warehouses. Marine Corps prepositioned assets are stored in humidity-controlled facilities either on ships or in caves in Norway. Humidity levels, particularly on ships, are required under Army and Marine Corps guidelines to stay within a specific range on a continuous basis and are closely monitored.

In addition to humidity-controlled storage, the Army and Marine Corps have taken other measures intended to help reduce the impact of corrosion on prepositioned assets. Army and Marine Corps policies require that repaired equipment be restored to good condition before being placed in prepositioned status. Specifically, Army maintenance

⁸With regard to readiness, for example, on October 24, 2005, the Army reported high readiness levels for prepositioned assets stored on ships in Army Strategic Flotilla II (Diego Garcia). Similarly, as of January 31, 2006, the Marine Corps reported high readiness levels for equipment stored on its prepositioning ships.

regulations require prepositioned equipment to be maintained at “10/20” standards,⁹ the highest standard the Army has for equipment maintenance. Army maintenance regulations also provide for the use of lubricants and preservatives, as well as regular inspections. Marine Corps policy indicates that all equipment generally will be in “Code A” condition at the time it is placed in storage.¹⁰ Code A means the equipment is serviceable without any limitation or restriction. Marine Corps officials told us equipment meeting this standard would have little to no corrosion. Marine Corps maintenance guidance for prepositioned equipment consists of a variety of corrosion prevention and mitigation measures, including visual inspections for leaks, corrosion removal and recoating, and preservation.¹¹ For equipment stored on the prepositioned ships, inspections are conducted on a periodic basis. Both Army and Marine Corps officials said corrosion is routinely treated as part of the maintenance process for restoring equipment to meet standards.¹²

Army Is Storing a Sizeable Portion of Its Land-Based Prepositioned Assets Outdoors

We identified several locations where the Army is storing a significant amount of land-based prepositioned assets outdoors without adequate sheltering. Specifically, we found equipment being stored outdoors at Camp Carroll, South Korea; Camp Arifjan, Kuwait; and Goose Creek, South Carolina. At these locations, assets are left relatively unprotected from moisture, sand, and other elements that contribute to corrosion. Army officials noted that unprotected equipment corrodes faster and will more quickly fall below required maintenance condition standards. At Camp Carroll in South Korea, about 30 percent of the Army’s Heavy Brigade Combat Team equipment—mostly sustainment stock—is stored

⁹Army Technical Manual 38-470. 10/20 refers to the suffix found on Army technical manuals pertaining to vehicle and equipment maintenance practices.

¹⁰Marine Corps Headquarters, *Prepositioning Programs Handbook* (March 2005).

¹¹The Marine Corps’ *Prepositioning Programs Handbook* describes the process used to maintain prepositioned equipment and supplies that are stored by subjecting them to periodic quality assurance inspections, replacement or rotation, and logistic support to maintain the highest state of combat readiness. See also *Corrosion Control Procedures; Depot Maintenance Activities for Marine Corps Equipment* (TM-3080-50); *Organizational Corrosion Prevention and Control Procedure for USMC Equipment* (TM-4795-12/1); and *U.S. Marine Corps Maritime Prepositioning Force Operations*, Marine Corps Warfighting Publication 3-32/Navy Tactics, Technicians, and Procedures 3-02.3.

¹²We visited maintenance facilities and spoke with personnel responsible for equipment maintenance, including treatment for corrosion, but we did not review how effective the services were in meeting maintenance standards.

outdoors in an often damp and humid region. The remaining equipment is stored in humidity-controlled facilities. Army officials told us that the equipment had been poorly maintained and, as a result, experienced many significant defects and readiness shortfalls, with corrosion being one of the primary problems.¹³ These officials said some of the equipment corroded faster and more severely because of being stored outside and, as a result, the Army incurred additional maintenance costs. Army officials in South Korea noted that it costs more to maintain equipment that is stored outside in part because the equipment needs to be inspected three times more often than equipment in humidity-controlled storage. Large amounts of Army prepositioned equipment are also stored outside in Kuwait where, according to DOD and Army officials, the environment is highly corrosive because of the humid climate, sand with high salinity levels, and strong winds. As of April 2006, the Army was storing outside nearly all of its prepositioned assets (numbering about 11,000 items) in Southwest Asia.¹⁴ At the Army's prepositioning afloat facility in Goose Creek, South Carolina, equipment is stored outside during the time it is not undergoing maintenance because of a lack of storage facilities. The amount of time equipment is stored outside ranges, on average, from 1 month to more than 3 months. In some cases, equipment is stored outside well over 3 months. For example, 44 M1A1 tanks and 10 fuel tankers sat outdoors for more than a year after undergoing maintenance and experienced a total of \$1.2 million in corrosion-related damage. Army officials said that prolonged periods of outdoor storage as happened in this case rarely occur, but that some period of outdoor storage is expected for equipment waiting upload.

Army officials acknowledged having an immediate need for additional sheltering, preferably with humidity control capability, for prepositioned equipment located in South Korea, Kuwait, and South Carolina. However, under current construction plans, additional storage facilities will not be available at all three sites until 2012 at the earliest. In South Korea and

¹³Until recently, the equipment located in South Korea suffered from serious maintenance deficiencies and readiness shortfalls because of long-standing management problems. The Army implemented an intense effort to address these deficiencies and reported that all equipment was restored to required maintenance standards by the end of fiscal year 2005. See GAO, *Defense Logistics: Better Planning and Accountability Needed to Ensure Mission Capability of Army Prepositioned Stocks in South Korea*, [GAO-05-751](#) (Washington, D.C.: Sept. 6, 2005).

¹⁴These data, in addition to Camp Arifjan, Kuwait, include smaller prepositioning sites in Qatar and Afghanistan.

Kuwait, Army officials said that even with the additional planned storage facilities, substantial amounts of equipment will still be stored outdoors. For example, officials estimated about 20 percent of equipment in Kuwait will remain outside. Officials cited competing funding priorities as the primary reason for not providing indoor storage for all land-based prepositioned assets. Army officials also cited uncertainties regarding the number and type of equipment and length of time it is stored, which make it difficult to accurately define storage requirements and justify funding for construction of additional storage facilities. In South Korea, Army officials told us the lack of available land limits their ability to construct new, or expand existing, facilities. These officials also said that estimating storage needs is difficult because of uncertainties regarding the consolidation and reconfiguration of U.S. Forces Korea facilities related to future force restructuring. Army prepositioning afloat officials said that the Goose Creek facility primarily is a maintenance facility and is not meant for the storage of equipment, which makes it difficult to justify the building of new storage space.

Although building additional storage will require Army investment, the use of humidity-controlled storage in general has been shown to provide a substantial return on investment. According to a study by the Army Cost and Economic Analysis Center, sheltering Army National Guard equipment in a humidity-controlled facility had a potential return on investment of a minimum of \$8 for every \$1 invested. The Army National Guard also estimates that it will have achieved a total of over \$1.2 billion in cost savings by fiscal year 2010. Most of the projected savings is based on having to perform less maintenance on equipment that is being preserved better in humidity-controlled facilities. The humidity-controlled sheltering program includes combat vehicles, trailers, radar systems, and other equipment located at Guard facilities in 45 states and U.S. territories. According to Army storage and maintenance guidelines, storage of equipment in facilities without humidity control—particularly in open storage without protection—not only invites greater and more rapid deterioration because of corrosion but requires increased surveillance, inspections, and maintenance. For example, whereas combat vehicles in humidity-controlled facilities need to be exercised and road tested every 30 months, vehicles stored without humidity control require exercising every 12 months. One of the benefits of humidity control is avoiding or at least minimizing these increased maintenance requirements.

Temporary Shelters May Be a Feasible Option

Given the competing funding priorities and other constraints cited by Army officials in providing additional storage facilities for prepositioned equipment, temporary shelters may be a feasible option to address immediate storage needs. Temporary shelters are available in a range of sizes, materials, and features, including humidity control. For example, “K-SPAN” temporary shelters are steel structures constructed on-site and set over a concrete foundation. These shelters may be dismantled, packaged, and relocated. Army officials told us that temporary shelters are used primarily in situations where immediate storage is required but may be durable enough to last for several years. Furthermore, they can be acquired faster than permanent facilities, which may take several years to plan, fund, and build. The military services have made prior use of temporary shelters in several locations, for both prepositioned and non-prepositioned equipment. For example, the Marine Corps uses temporary humidity-controlled facilities in Florida to store some of its prepositioned assets awaiting maintenance and upload to ships. In addition, the Army has stored prepositioned equipment in temporary shelters located in Livorno, Italy, and Camp Carroll, South Korea. The Marine Corps has also used temporary shelters to store non-prepositioned equipment in Hawaii.

Lack of Corrosion Data Impairs Army and Marine Corps Ability to Support Prevention and Mitigation Efforts and Achieve Long-term Cost Savings

The lack of available corrosion data impairs the ability of the Army and Marine Corps to achieve long-term costs savings through corrosion prevention and mitigation efforts. The Army and Marine Corps consider collection of corrosion data on prepositioned assets to be a low priority and, consequently, do not systematically collect them. These data could be used to support additional prevention and mitigation efforts that achieve long-term cost savings, similar to the Army’s previous success using corrosion data regarding non-prepositioning programs.

Army and Marine Corps Are Not Collecting Corrosion Data on Prepositioned Assets

Corrosion-related data that could enhance efforts to prevent and mitigate corrosion of prepositioned assets is unavailable because the Army and Marine Corps consider collection of this information to be a low priority and, consequently, do not systematically collect it. Army regulations require units to collect corrosion-related data as part of their equipment

maintenance and storage programs, while the Marine Corps generally lacks requirements for collection of corrosion-related data.¹⁵ For example, the Army's Corrosion Prevention and Control Program regulation includes a requirement for a corrosion-related survey of all divisions and separate combat brigades to be conducted at least every 4 years.¹⁶ In addition, Army policy on reporting equipment quality deficiencies includes a requirement to report problems that are corrosion related.¹⁷ The Marine Corps, on the other hand, does not require the collection of corrosion information for all equipment, but believes it to be beneficial. The mission of the Marine Corps' Corrosion Prevention and Control Program is to reduce maintenance requirements and costs associated with corrosion, and the program seeks to identify and assess current and projected corrosion problems for all tactical ground and ground support equipment. Marine Corps officials said that the desire for the collection of corrosion information applies to all Marine Corps activities, including prepositioning programs, but acknowledge that data are not collected on prepositioned assets because they have a low priority. Corrosion data could be used to help identify underlying causes of maintenance problems and obtain a better understanding of the costs of corrosion and the extent it affects readiness.

Despite Army corrosion data collection requirements and the establishment of corrosion prevention and control programs in the Army and Marine Corps, we found that information about corrosion of prepositioned assets is generally lacking in both services. We reviewed a wide range of reports and other documentation on Army and Marine Corps prepositioned equipment and found these to be almost devoid of corrosion-related data. For example, we examined information on the

¹⁵Marine Corps mishap and safety recordkeeping and reporting guidance requires the collection and reporting of mishap causes, including some information on corrosion, if relevant. For example, when a mishap occurs, corrosion problems, such as corroded parts, corrosion control inadequacies or preservation failures, should be listed in the mishap report if they were causes of the mishap. OPNAVINST 5102.1D.

¹⁶According to Army Regulation 750-59, these surveys are to include an assessment of the condition of equipment, to include prepositioned material; an evaluation of program management and procedures; and the development of corrective action plans.

¹⁷According to Department of the Army Pamphlet 738-750, *Functional Users Manual for The Army Maintenance Management System (TAMMS)*, quality deficiencies, such as those caused by corrosion, are to be reported when the defect may cause death, injury, or severe illness; would cause loss or major damage to a weapon system; or critically restricts combat readiness capabilities.

maintenance condition and repair actions for prepositioned equipment from the Army Maintenance Management System, but this system did not contain information regarding the extent and nature of equipment corrosion. Likewise, the cost data on prepositioned equipment contained in the Marine Corps' Standard Accounting, Budgeting and Reporting System, which contains total maintenance and repair costs for all prepositioned equipment, also did not include information specifically on corrosion costs. We also asked the Army and Marine Corps for information regarding the impact of corrosion on maintenance costs, equipment deficiencies, inventory levels, and readiness rates. In almost every instance, this corrosion information was not available. As we have previously reported, DOD and the military services generally have a limited amount of corrosion data related to cost estimates, readiness, and safety data.¹⁸

According to Army and Marine Corps officials, corrosion information on prepositioned assets is unavailable primarily because it has low priority. Although Army guidance for documenting equipment maintenance includes detailed instructions for reporting corrosion issues, Army officials said most of those responsible for documenting the maintenance action do not want to take the extra time to include corrosion information because they see it as having minimal value and have no incentive to collect it. Similarly, Marine Corps officials stated that there is minimal incentive to capture and report corrosion costs for prepositioned equipment because maintenance costs are typically managed at more general levels, such as the costs to repair or replace a piece of equipment. Officials from both the Army and the Marine Corps said that corrosion is routinely treated as part of the overall maintenance process, and corrosion-related data are not tracked separately. For example, Army officials at Camp Carroll, South Korea, told us that corrosion observed on the engine blocks in 5-ton trucks would be repaired during maintenance performed on the entire engine and would not be noted in the maintenance logs. Instead, documentation of the maintenance actions would include a description of the equipment or component and why it was not functional—such as being broken or cracked—but would not include the reason for the repair, such as corrosion. According to Marine Corps officials, corrosion information has value but not enough to be included with more critical information, such as the amount of equipment in the inventory and amount in serviceable condition.

¹⁸ [GAO-03-753](#).

Although the Army and Marine Corps are not collecting data about the current costs to prevent and mitigate corrosion of prepositioned assets, the military services have estimated that at least 25 percent of overall maintenance costs are corrosion related and that as much as one-third of these costs could be reduced through more effective corrosion prevention and mitigation. Army and Marine Corps officials told us that this estimate applies to both prepositioned and non-prepositioned assets because corrosion affects both types of equipment in similar ways. Because of the lack of available cost data, the Army, at our request, conducted a limited review of maintenance records for about 2,000 pieces of prepositioned stock in South Korea. The Army determined that about \$8.7 million (31 percent) of the estimated \$28 million spent to restore this equipment to serviceable condition was used to address corrosion-related problems. As another indication of corrosion costs, Marine Corps officials estimated that corrosion costs make up at least 50 percent of the \$110,000 needed, on average, to repair motorized lighterage¹⁹ prepositioned equipment.

Corrosion Data Could Be Used to Support Additional Prevention and Mitigation Efforts That Achieve Long-term Cost Savings

The additional information that would be obtained through the collection of corrosion data could support the Army's and Marine Corps' efforts to more effectively prevent and mitigate corrosion and achieve long-term cost savings, which could be significant given the resources the military services devote each year to addressing corrosion-related problems. Corrosion prevention measures may reduce the amount of maintenance needed, thereby extending the availability of equipment items over their life cycle. The Army has had previous success using corrosion data regarding non-prepositioning programs to support corrosion prevention and mitigation efforts that achieved long-term cost savings. For example, the Army National Guard began the initial phase of a humidity-controlled storage program for its vehicles and equipment in 1994. Guard officials told us that they collected and analyzed an extensive amount of information on corrosion and its cost impacts on selected pieces of equipment and estimated that a significant amount of corrosion-related costs could be avoided by using humidity-controlled storage facilities. Program officials currently estimate that the sheltering and preservation effort will save a total of about \$1.2 billion through fiscal year 2010, which

¹⁹Lighterage is small craft—powered and nonpowered—designed to transport cargo or personnel from ship to shore. Lighterage includes amphibious vehicles, landing craft, causeways, and barges. Marine Corps officials estimate that at least 50 percent of the \$35,000 needed to repair the average nonmotorized lighterage equipment is used to address corrosion-related damage.

reflects a 9 to 1 return on investment. Army officials cited similar results after collecting corrosion data on Hellfire missile launchers. The types and areas of the launchers that were most prone to corrosion—such as missile safety/arming switches—were identified and documented. Based on this research, maintenance technicians knew better to look for corrosion and how to control it before it worsened. The Army Missile Command’s tactical missile program executive office attributed a large portion of its \$3.2 billion overall long-term life cycle savings to the Hellfire corrosion prevention measures. Collection of corrosion data for prepositioned equipment could better enable the Army and Marine Corps to support similar corrosion prevention and mitigation efforts in their prepositioning programs.

Conclusions

Effectively addressing corrosion on prepositioned stocks of equipment can enable the services to achieve significant cost savings and increase readiness and safety for rapidly fielding combat-ready forces around the world. Although the Army and Marine Corps have taken measures to reduce the impact of corrosion on prepositioned assets, there are immediate opportunities for taking additional action. Sheltering assets—especially sheltering in humidity-controlled facilities—has been shown to be a key anticorrosion practice, yet large amounts of Army land-based prepositioned assets are stored outdoors without adequate sheltering. This practice is wasteful given the large investment in acquiring the equipment and the annual costs of maintaining it. Furthermore, while the Army and Marine Corps do not collect corrosion data for prepositioned equipment, the collection of such data could provide additional information to identify the underlying causes of maintenance problems and develop solutions to address these problems. Without such data, the services may lack the incentive to support efforts to more effectively prevent and mitigate corrosion and achieve long-term cost savings. Until the Army and Marine Corps take additional actions to prevent corrosion, such as implementing use of temporary shelters to the greatest extent feasible and collecting corrosion-related data, prepositioned equipment stored outdoors will continue to corrode at an accelerated pace and the services will continue to incur unnecessary costs for maintaining equipment and repairing corrosion damage.

Recommendations for Executive Action

To reduce the impact of corrosion on prepositioned assets and support additional corrosion prevention and mitigation efforts, we recommend that the Secretary of Defense take the following three actions:

-
- Direct the Secretary of the Army to examine the feasibility of using temporary shelters, including humidity-controlled facilities, to store land-based prepositioned assets currently stored outdoors, and if such use is determined to be feasible, to take appropriate actions to implement the use of shelters to the maximum extent possible.
 - Direct the Secretary of the Army to collect corrosion-related data, as required in existing Army regulations, and use these data to support additional corrosion prevention and mitigation efforts.
 - Direct the Commandant of the Marine Corps to require the collection of corrosion-related data and use these data to support additional corrosion prevention and mitigation efforts.

We also recommend that the Secretary of Defense direct the Under Secretary of Defense for Acquisition, Technology, and Logistics to specify the department's planned actions, milestones, and resources for completing an Army feasibility study on the use of temporary shelters to store land-based prepositioned assets and for collecting and using Army and Marine Corps corrosion-related data to support additional corrosion prevention and mitigation efforts.

Agency Comments and Our Evaluation

In commenting on a draft of this report, DOD concurred with our recommendations that the Army consider the feasibility of using temporary shelters, including humidity-controlled facilities, to store land-based prepositioned assets currently stored outdoors and that the Army and Marine Corps collect and use corrosion-related data to support additional corrosion prevention and mitigation efforts. However, DOD did not provide specific information on planned actions, milestones, and resources for implementing the recommendations. With respect to the Marine Corps, DOD stated that collection of adequate data is not a matter of being a low priority but a funding issue. As noted in our report, we were told by Marine Corps officials that collection of these data has been a low priority. We believe that funding and priorities should be aligned to the greatest extent possible to provide greater assurance that the department's resources are being used prudently. As stated in our report, DOD can achieve long-term cost savings by investing in additional corrosion prevention and mitigation efforts. In addition, investments in corrosion prevention measures may reduce the amount of maintenance needed on equipment items, thereby extending the availability of equipment items over their life cycle. On the basis of our evaluation of DOD's comments, we have added a recommendation that DOD specify actions, milestones,

and resources for implementing our recommendations to the Army and the Marine Corps.

DOD's comments are reprinted in appendix II.

Scope and Methodology

We focused our review on the prepositioned assets managed by the Army and Marine Corps because these two services have the majority of the military's prepositioned assets, and these services provided most of the equipment used in current operations in Southeast Asia.

To assess the measures taken by the Army and Marine Corps to reduce the impact that corrosion has on prepositioned assets, we met with DOD and service command officials responsible for managing and maintaining prepositioned assets; obtained their assessments and perspectives on corrosion prevention and mitigation programs and strategies; and obtained and reviewed DOD and service policies, procedures, and practices, including technical orders and manuals, for managing and maintaining prepositioned assets. We met with DOD officials involved with developing DOD's long-term strategy to prevent and control corrosion. We also discussed additional actions that could be taken to further prevent and mitigate corrosion. In addition, we visited selected prepositioning locations and maintenance facilities, including the Army's facilities in Goose Creek, South Carolina, and Camp Carroll, South Korea, and the Marine Corps Logistics Command in Albany, Georgia, and Blount Island Command in Jacksonville, Florida.

To assess the availability of corrosion-related data to the Army and Marine Corps to support corrosion prevention and mitigation efforts for prepositioned assets, we met with DOD and service command officials responsible for managing and maintaining prepositioned assets, and obtained and reviewed DOD and military service policies and procedures for collecting and reporting maintenance costs and related equipment material condition information. We obtained and analyzed various cost and maintenance reports on these assets, including inspection and maintenance logs, databases and assessments, and after-action reports. In particular, we discussed the barriers that exist to identifying and quantifying the impact of corrosion on prepositioned assets' maintenance costs and material condition, and the metrics and related information systems needed to better collect, track, report, and manage efforts to prevent and mitigate corrosion as well as quantify the related funding requirements to address this issue.

We interviewed officials and obtained documentation at the following locations:²⁰

- Office of the Secretary of Defense
 - Corrosion Policy and Oversight Office
- Joint Chiefs of Staff
 - Director of Logistics
- Army
 - Headquarters, Department of the Army
 - U.S. Army Materiel Command, Fort Belvoir, Virginia
 - Tank-Automotive and Armaments Command, Warren, Michigan, and Rock Island, Illinois
 - U.S. Army Field Support Command, Rock Island, Illinois
 - U.S. III Army Corps, Fort Hood, Texas
 - U.S. Army Field Support Battalion Afloat, Goose Creek, South Carolina
 - U.S. Forces Korea and Eighth U.S. Army, Yongsan Garrison, South Korea
 - U.S. Army Field Support Battalion Far East, Camp Carroll, Waegwan, South Korea
 - Materiel Support Center Korea, Camp Carroll, Waegwan, South Korea
 - 19th Theater Support Command, Camp Walker, Daegu, South Korea
 - U.S. Army Pacific, Fort Shafter, Hawaii
- Marine Corps
 - U.S. Marine Corps Headquarters
 - U.S. Marine Corps Forces, Pacific, Hawaii
 - I Marine Expeditionary Force, Camp Pendleton, California
 - II Marine Expeditionary Force, Camp Lejeune, North Carolina
 - III Marine Expeditionary Force, Okinawa, Japan
 - Marine Corps Systems Command, Quantico, Virginia
 - Marine Corps Logistics Command, Albany, Georgia

²⁰Unless otherwise noted, the officials listed have their offices in the Pentagon or at locations in the Washington, D.C., metropolitan area.

-
- Blount Island Command, Jacksonville, Florida
 - Office of the Inspector General of the Marine Corps

 - Navy
 - Bureau of Medicine and Surgery
 - Naval Facilities Engineering Command
 - CNA Corporation, Alexandria, Virginia
 - U.S. Navy Inspector General
 - Naval Air Systems Command, Office of the Inspector General, Patuxent River, Maryland
 - Naval Audit Service
 - Naval Medical Logistics Command, Fort Detrick, Maryland
 - Navy Expeditionary Medical Command, Cheatham Annex, Williamsburg, Virginia
 - Military Sealift Command

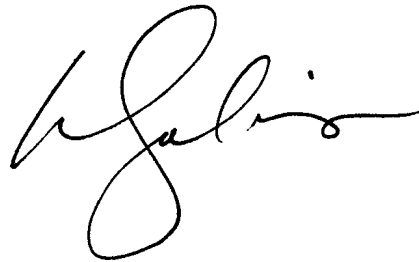
 - Air Force
 - Headquarters, Seventh Air Force, South Korea

 - Unified Commands
 - United States Pacific Command
 - United States Forces Korea

We conducted our work from May 2005 through February 2006 in accordance with generally accepted government auditing standards. We reviewed available data for inconsistencies and discussed the data with DOD and service officials. We determined that the data used for our review were sufficiently reliable for our purposes.

We are sending copies of this report to the Secretary of Defense, the Secretary of the Army, and the Commandant of the Marine Corps. We will also make copies available to others upon request. In addition, this report is available at no charge on the GAO Web site at <http://www.gao.gov>.

If you or your staffs have any questions, please contact me at (202) 512-8365. Contact points for our Offices of Congressional Relations and Public Affairs may be found on the last page of this report. Key contributors to this report are listed in appendix III.

A handwritten signature in black ink, appearing to read 'W. Solis', with a stylized flourish at the end.

William M. Solis, Director
Defense Capabilities and Management

Appendix I: Military Services' Prepositioning Programs

The military services have prepositioning programs to store combat or support equipment and supplies near areas with a high potential for conflict and to speed response times and reduce the strain on other mobility assets.

The Army's program involves three primary categories of stocks: combat brigade sets, operational projects, and war reserve sustainment stocks stored at land sites and aboard prepositioning ships around the world. The Marine Corps also prepositions equipment and supplies aboard prepositioning ships and at land sites in Norway. The Navy's prepositioning efforts are comparatively small, used mainly to support the Marine Corps' prepositioning program and deploying forces. The Navy prepositions equipment and supplies at land sites and aboard the maritime prepositioning ships. The Air Force prepositions stocks of war reserve equipment and supplies to meet initial contingency requirements and to sustain early deploying forces. The Air Force's prepositioned war reserve stocks include bare base sets; vehicles; munitions; and a variety of consumable supplies, such as rations, fuel, support equipment, aircraft accessories, and medical supplies. The services' prepositioning programs are briefly described in table 1.

Table 1: Description of Prepositioning Programs

Service	Types of stocks	Description
Army	Combat brigade sets	<ul style="list-style-type: none"> • Stored at land sites and aboard prepositioning ships • Sets are designed to support 3,000 to 5,000 soldiers • Heavy weaponry, such as tanks and Bradley fighting vehicles • Support equipment, such as trucks and High Mobility Multi-purpose Wheeled Vehicles • Spare parts and other sustainment stocks to support the early stages of a conflict
	Sustainment stocks	<ul style="list-style-type: none"> • Stored at land sites and aboard prepositioning ships • Replacement equipment for losses in early stages of operations or until resupply is established • Includes major end items, such as aircraft engines and tracked vehicles • Secondary items, such as meals, clothing, petroleum supplies, construction materials, ammunition, medical materials, and repair parts
	Operational project stocks	<ul style="list-style-type: none"> • Stored at land sites and aboard prepositioning ships • Authorized material above unit authorizations designed to support Army operations or contingencies • Equipment and supplies for special operations forces, bare base sets, petroleum and water distribution, mortuary operations, and prisoner-of-war operations

Appendix I: Military Services' Prepositioning Programs

Service	Types of stocks	Description
Navy/Marine Corps	Maritime prepositioning force	<ul style="list-style-type: none"> Consists of 16 prepositioning ships organized into three squadrons Each squadron supports about 15,000 Marines for up to 30 days Includes combat systems, communications systems, construction equipment, munitions, medical supplies, and sustainment stocks
	Prepositioning program- Norway	<ul style="list-style-type: none"> Several land sites located in central Norway Designed to support 13,000 Marines for up to 30 days Includes vehicles, weapons, munitions, rations, and other equipment that will be used to support any geographic combatant command
	Navy prepositioned assets	<ul style="list-style-type: none"> Assets are stored aboard maritime prepositioning ships and at land sites Equipment to offload prepositioning ships, including material handling equipment, ramps and barges, landing and amphibious craft, and bulk fuel Construction equipment, such as cranes, forklifts, trucks, and tractor trailers Includes six 500-bed fleet hospitals^a
Air Force	Bare base sets	<ul style="list-style-type: none"> Base operating support equipment used to house forces, and equipment and supplies needed to support airfield operations
	Vehicles	<ul style="list-style-type: none"> Includes trucks, buses, and High Mobility Multi-purpose Wheeled Vehicles
	Other support equipment and supplies	<ul style="list-style-type: none"> Includes materiel handling equipment, rations, fuel, fuel support equipment, aircraft accessories, and medical supplies at land sites and munitions aboard four prepositioning ships

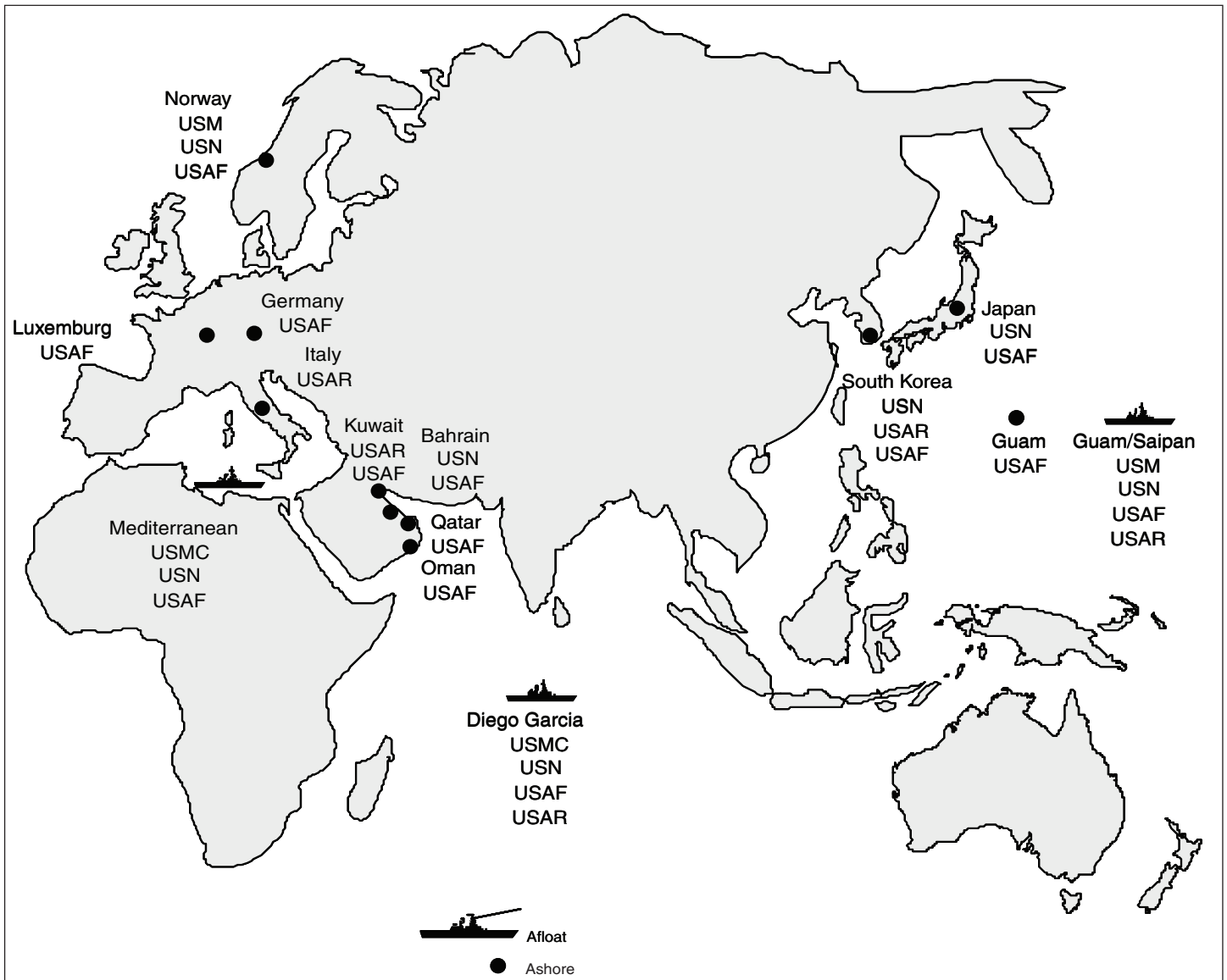
Source: GAO.

Notes: In addition to the services' programs, the Defense Logistics Agency prepositions food and bulk fuel to support a range of contingency operations and training exercises. The Special Operations Command relies on the military services to preposition common support items for its forces, such as base support items and vehicles.

^aThe Navy is in the process of transitioning from 500-bed fleet hospitals to smaller modular units.

The military services store these stocks of equipment and supplies at several land sites and aboard prepositioning ships around the world. Most of the military services store equipment and supplies in Southwest Asia, the Pacific theater, Europe, and aboard prepositioning ships. Figure 1 shows the major locations of prepositioned stocks.

Figure 1: Locations of Army (USAR), Marine Corps (USMC), Navy (USN), and Air Force (USAF) Prepositioned Stocks



Source: GAO analysis.

Note: DOD also prepositions smaller stocks of equipment and supplies at other locations not identified on this map.

Appendix II: Comments from the Department of Defense



ACQUISITION
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OFFICE OF THE UNDER SECRETARY OF DEFENSE
3000 DEFENSE PENTAGON
WASHINGTON, DC 20301-3000

JUN 05 2006

Mr. William M. Solis
Director, Defense Capabilities and Management
U.S. Government Accountability Office
Washington, D.C. 20548

Dear Mr. Solis:

This is the Department of Defense (DoD) response to the GAO Draft Report GAO-06-709, "DEFENSE MANAGEMENT: Additional Measures to Reduce Corrosion of Prepositioned Military Assets Could Achieve Cost Savings," dated April 28, 2006 (GAO Code 350648).

The Department continues to consider corrosion to be an important issue associated with cost, readiness, and safety of its weapon systems and facilities. As a result, emphasis on prevention and mitigation of corrosion across all mission areas and obligations remain a top priority within the Department.

The GAO report makes three "Recommendations for Executive Action." We concur and are committed to meeting the requirements of the Congress and, to the extent possible, implementing the positive recommendations of the subject GAO response. The Department's primary point of contact for this report is Daniel J. Dunmire, Special Assistant, DoD Corrosion Policy and Oversight.

Mark D. Schaeffer
Director
Systems and Software Engineering

Enclosure:
DoD Recommendations for Executive Action



GAO DRAFT REPORT – DATED April 28, 2006
GAO CODE 350648/GAO-06-709

"DEFENSE MANAGEMENT: Additional Measures to Reduce Corrosion of Prepositioned
Military Assets Could Achieve Cost Savings"

DEPARTMENT OF DEFENSE COMMENTS
TO THE RECOMMENDATIONS

RECOMMENDATION 1: The GAO recommended that the Secretary of Defense direct the Secretary of the Army to examine the feasibility of using temporary shelters, including humidity-controlled facilities, to store land-based prepositioned assets currently stored outdoors, and if such use is determined to be feasible, to take appropriate actions to implement the use of shelters to the maximum extent possible. (Page 12/GAO Draft Report)

DoD RESPONSE: Concur.

The U. S. Army has identified humidity controlled facilities as a key technology to prevent corrosion on prepositioned assets. The Army is already evaluating potential storage options for prepositioned assets currently stored outdoors in Army Preposition Stocks. Controlled-humidity is a requirement for newly built facilities both on land and sea. All U.S. Army future prepositioned stocks strategies will include review of available facilities as part of the selection of prepositioned locations.

RECOMMENDATION 2: The GAO recommended that the Secretary of Defense direct the Secretary of the Army to collect corrosion-related data, as required in existing Army regulations, and use these data to support additional corrosion prevention and mitigation efforts. (Page 13/GAO Draft Report)

DoD RESPONSE: Concur.

The U.S. Army requires the establishment of and tracking metrics for all corrosion-prevention projects funded by their corrosion prevention and control office. The U.S. Army Materiel Command is capturing metrics for specific weapon systems/facility projects, and these data are used to evaluate the effectiveness of these projects.

RECOMMENDATION 3: The GAO recommended that the Secretary of Defense direct the Commandant of the Marine Corps to require the collection of corrosion-related data and use these data to support additional corrosion prevention and mitigation efforts. (Page 13/GAO Draft Report)

DoD RESPONSE: Concur.

Now on p.18.

Now on p.18.

Now on p. 18.

**Appendix II: Comments from the Department
of Defense**

The Marine Corps Corrosion and Control Program Office agrees that the Marine Corps maintenance reporting system does not provide sufficient information to determine the condition of assets as related to corrosion. Data is not adequate for determining either cost of corrosion or mission readiness related to corrosion, but the tools for collecting and analyzing the data exists. Collection of adequate data is not a matter of being a low priority to the Marine Corps but a funding issue.

Appendix III: GAO Contact and Staff Acknowledgments

GAO Contact

William M. Solis (202) 512-8365 or solisw@gao.gov

Acknowledgments

In addition to the contact named above, Thomas Gosling, Assistant Director; Larry Bridges; Renee Brown; Lisa Canini; Amy Sheller; Allen Westheimer; and Tim Wilson were major contributors to this report.

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